The invariant imbedding principle applied to light scattering by nonspherical particles: a review

Lei Bi

Department of Atmospheric Sciences, Zhejiang University, Hangzhou, 310027, China
(bilei@zju.edu.cn)

Although the invariant imbedding principle had gained popularity in radiative transfer and computational mathematics a long time ago, the concept's power in light scattering by nonspherical particles has only been explored in recent years. Unlike solving Maxwell's equation in conjunction with boundary conditions, this principle transforms the boundary value problem into an initial value problem in the framework of an electromagnetic volume integral equation. In this talk, I will summarize the invariant imbedding principle for the solution of the T-matrix equations as well as Debye's series of nonspherical particles [1–4], and discuss current modeling capabilities of the aforementioned techniques. The invariant imbedding T-matrix method computes the optical properties of nonspherical (inhomogeneous) particles. Debye's series helps understand the scattering mechanism and, in particular, the semi-classical scattering effect beyond geometric-optics or physical-optics approaches. Moreover, I will illustrate the use of Debye's series to determine an optimized high frequency extinction formula for spheroids in the context of the complex angular momentum theory pioneered by Nussenzveig and Wiscombe [5] for a homogeneous sphere. Finally, I will report on representative calculations for nonspherical particles, including ice crystals, aerosols, red blood cells, and coccolithophores, and also highlight relevant downstream applications in both particle characterization and remote sensing.

References

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